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# Percutaneous Radiofrequency Trigeminal Gangliolysis in the Treatment of Tic Douloureux

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*The treatment of tic douloureux was dramatically altered in 1962 with the demonstration that carbamazepine (Tegretol®) alone or in combination with diphenylhydantoin sodium (Dilantin®) was effective in controlling the painful paroxysms. However, 30 percent of the patients so treated have not been successfully managed and some type of surgical therapy is required to control their pain. A wide variety of surgical alternatives are available but they all trade a sensory deficit for pain relief and have a significant risk of morbidity and mortality.*

*Experience with percutaneous radiofrequency trigeminal gangliolysis has indicated that this new technique is capable of producing lasting relief of tic douloureux in as many as 95 percent of the patients. To date there have been no deaths from this procedure and a very low incidence of minor complications. It achieves this high success rate at the expense of only partial sensory deficits restricted to a circumscribed area of the face. No other surgical alternative carries such a high long-term success rate with a low complication rate. We believe that percutaneous radiofrequency trigeminal gangliolysis has become the surgical treatment of choice for tic douloureux.*

TIC DOULOUREUX is a paroxysmal facial pain of unknown cause and pathophysiology. It has the following characteristics: (1) Intermittent, sharp, lancinating electric shock-like pains limited to the

trigeminal nerve distribution. Rarely, the pain is perceived in the territory of the nervus intermedius or glossopharyngeal nerve. (2) There are pain-free intervals. (3) The pain is always unilateral. (4) The pain is precipitated by nonnoxious stimulation in a repeatedly demonstrable trigger area which is always ipsilateral to the pain. (5) Results of neurologic examination are usually normal but may show mild sensory changes in the area in which the pain is perceived. (6) The frequency of paroxysms is very

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# TIC DOULOUREUX

variable, occurring often in clusters which last days, weeks or months, but sometimes with spontaneous remissions between flurries of attacks.

Rothman estimates that there are 7,000 new cases of tic douloureux each year in the United States.<sup>1</sup> Approximately 70 percent of these patients can be successfully controlled by using carbamazepine (Tegretol®).<sup>2-6</sup> By adding diphenylhydantoin sodium (Dilantin®) to Tegretol another 10 to 15 percent can be controlled.<sup>5</sup> Serious side effects can require cessation of Tegretol administration in 5 to 19 percent of the patients taking this drug (skin rash, leukopenia, thrombocytopenia, abnormal liver function tests).<sup>3,5,6</sup> Consequently, in 30 percent of the patients with tic douloureux, pain will not be controlled by medication. No other drugs have been reliably effective for the control of the pain of tic douloureux.

A wide variety of effective curative and palliative surgical procedures designed to damage the trigeminal nerve exist. The literature is replete

with advocates of every conceivable technique for traumatizing or excising the trigeminal system from the periphery to the brain stem. These procedures are summarized in Table 1. They have in common the goal of producing some sensory deficit in the painful region without producing other neurological deficits, morbidity or mortality. Since several of the complications of surgical operation for tic douloureux are directly related to the amount of sensory deficit produced (anesthesia dolorosa, neuroparalytic keratitis, paresthesia), it seems to be of value to limit the sensory deficit to the minimum necessary to achieve long-lasting pain relief.

We present here our initial experience with percutaneous radiofrequency trigeminal gangliolysis. This procedure offers the ability to limit the sensory deficit to a preselected region of the face and to just the "pain modality"; hypalgesia or analgesia without anesthesia is produced. We have used with slight modifications the technique

TABLE 1.—Destructive Procedures for Tic Douloureux

Procedure	Effectiveness		Sensory Deficits	Complications
	Immediate (Percent)	Long-term (Percent)		
Peripheral neurectomy . . . .	79-100	0-14*	Anesthesia and analgesia	Mortality 0; minor and rare, anesthesia dolorosa reported, incidence unknown
Alcohol injection				
Nerve <sup>9,13</sup> . . . . .	80-90	0-10†	Variable, usually anesthesia and analgesia	Spread of alcohol to other cranial nerves and brain stem can occur, mortalities reported
Ganglion <sup>8,9,11-15</sup> . . . . .	97	70	Anesthesia and analgesia	Mortality 0-1%; corneal anesthesia 15-44%; keratitis 15-44%; anesthesia dolorosa 5-12%; spread to other cranial nerves and brain stem—incidence not documented
Intracranial				
Middle fossa <sup>7</sup> trigeminal rhizotomy . . . .	99	90	Anesthesia and analgesia	Mortality 0.4-3.4%; keratitis 5%; anesthesia dolorosa 10%; other cranial nerves 2%
Middle fossa <sup>7</sup> ganglion percussion . . . .	98	77	Variable, hypalgesia and hypesthesia	Mortality 1-2%; keratitis 0; anesthesia dolorosa 0; other cranial nerves 3%
Posterior fossa <sup>7</sup> trigeminal rhizotomy . . . .	100	70-80	Analgesia and anesthesia	Mortality 2.0-4.5%; keratitis 1-2%; anesthesia dolorosa 2%; other cranial nerves 2%
Medullary <sup>7</sup> trigeminal tractotomy . . . .	89	80	Analgesia without anesthesia	Mortality 1%; keratitis 0.8%; anesthesia dolorosa 0.4%; ataxia 6%; variable lower cranial nerve palsies
Radiofrequency <sup>16-18</sup> trigeminal gangliolysis . . . .	99	80-90	Analgesia without anesthesia	Mortality 0; keratitis 0.6%; anesthesia dolorosa 1.3%; other cranial nerves 0

\*Virtually 100 percent have return of pain within one year.

†Virtually 100 percent recurrence with 8 to 16 months.

described by Sweet and Wepsic.<sup>7,16</sup> Their original work was based upon Kirschner's diathermic coagulation of the Gasserian ganglion begun in 1925. The technique as then practiced made use of general anesthesia and produced a significant number of severe complications.<sup>7</sup> By 1972, Thiry had refined the procedure by making partial lesions.<sup>19</sup> At this point the technique had similar complications and success rates to the open surgical and anesthetic neurodestructive procedures. Schürmann and co-workers improved the technique by using neuroleptic analgesia, allowing them to monitor the sensory deficit produced during the course of the operation.<sup>20</sup> Sweet and Wepsic's modifications included electrical stimulation through the needle to verify the location of the needle tip before making the lesion, and the use of radiofrequency current to produce a thermally generated lesion which was much more controllable than diathermy electrical coagulation. In addition, temperature monitoring with a thermistor was used to prevent sudden overheating and gassing at the electrode tip.

### Technique

The objective of this technique is to limit the lesion to just those fibers of the trigeminal nerve that are involved in the pain. This is accomplished by percutaneously introducing a needle through the foramen ovale into the Gasserian ganglion under fluoroscopic control. Since this part of the procedure can be painful, brief neuroleptic anesthesia is useful; we now use premedication with fentanyl citrate and droperidol (Innovar®) and intermittent inhalation of nitrous oxide and oxygen (N<sub>2</sub>O-O<sub>2</sub>) by mask. Once the needle is in the ganglion, low voltage, 60 hertz stimulation is used to produce paresthesiae which are perceived by the patient in the peripheral distribution of the fibers among which the electrode tip is lying. The patient reports where he feels the paresthesiae and the electrode is adjusted to produce the tingling sensation in the area where the patient has previously perceived his pain. Low frequency (5 to 10 Hz) stimulation is then used to ascertain that the motor division is not close to the electrode tip. When the needle is adjacent to the appropriate fibers the radiofrequency current is turned on and the temperature of the tip is gradually raised to 70°C. If the temperature is allowed to rise very slowly (over a three minute period) the patient may not feel significant pain; however, some patients do

find the thermal coagulation of the ganglion painful and, for this reason, brief neuroleptic anesthesia with nitrous oxide is useful. The desired electrode temperature is maintained for 90 seconds to produce a permanent lesion within the ganglion. The patient is then awakened from the anesthetic and examined for sensory deficits. If more deficit is required the lesion can be enlarged by reheating to 80°C for 90 seconds. The needle can also be shifted to a more suitable location and another lesion produced. In this way the location and size of the lesion can be controlled and unwanted neurologic deficits avoided.

The technique of percutaneous radiofrequency trigeminal gangliolysis takes advantage of the fact that the unmyelinated and thinly myelinated fibers are very much more sensitive to heating and are damaged preferentially during gangliolysis. All available clinical and experimental evidence supports the concept that these Aδ and C fibers are the only sources of peripheral nociceptive information; the patient develops a sensory deficit limited only to the "pain modality."<sup>21</sup> Touch and proprioceptive modalities are left intact. At the end of the procedure the tic pain is eliminated. The sensory deficit is discretely localized and is restricted primarily to the perception of pain and temperature.

### Results

This report includes our initial group of 32 consecutive patients with tic douloureux, drawn from the University of Washington Affiliated Hospitals. All procedures were done between January 1973 and May 1975. The average age of our patients was 61, ranging from 31 to 77. There were 19 women and 13 men. They had an average duration of symptoms of 7.7 years, ranging from one month to 25 years. In many of the patients there was a past history of remission, either spontaneous or induced by medical or surgical therapy. Seventeen of the patients had been treated earlier with a neurodestructive procedure, the most common being alcohol block of the nerve or Gasserian ganglion.

Of our 32 patients, 31 had been treated with Tegretol, one was treated with Dilantin alone. Of the 31 who received Tegretol, 12 received Dilantin in addition. Of these 31 patients, in 9 there was no relief at all from either of these drugs, in 12 there was partial or incomplete relief and in 5 others there was control of pain for several months to several years; then it "broke

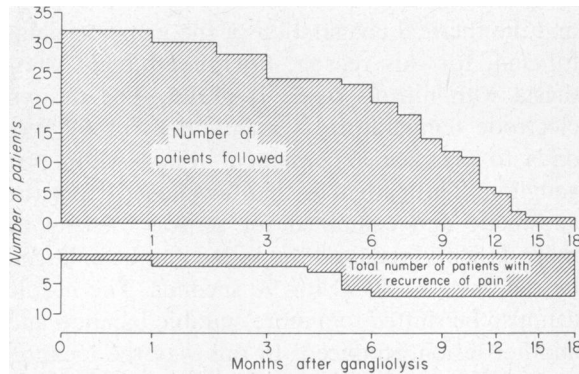


Figure 1.—Gangliolysis for tic douloureux.

through” and no relief was achieved even when the drugs were carried to toxic levels. These 26 patients underwent gangliolysis because of poor control of pain. In an additional five patients there was control with Tegretol but toxic symptoms developed that required withdrawal of the drug. All of our 32 patients were examined one month postoperatively and at regular intervals thereafter and were then interviewed in June 1975 by telephone or in person. Therefore, we have follow-up periods ranging from 1 to 17 months.

In only one of the 32 patients was there failure to achieve any relief of pain. Most of the others were pain-free from the time of the gangliolysis, although a few experienced brief attacks of pain in the immediate postoperative hours before achieving lasting relief.

Six patients had return of their original tic pain during the follow-up period. In two pain recurred within one month and in one each at four, five, seven and eight months after gangliolysis (Figure 1). Of the entire series, followed until June 1975, this represents a 21 percent recurrence of pain. Of the seven patients with pain recurrence, five had had earlier neurodestructive procedures carried out involving the trigeminal ganglion. This may indicate that either their tic was more refractory to control by any method or that the earlier procedure itself decreased the ability of the gangliolysis to achieve the therapeutic effect. It was observed during gangliolysis that in those patients in whom earlier procedures affecting the Gasserian ganglion had been carried out, it was much more difficult to produce paresthesiae in the desired location and much more difficult to achieve an adequate lesion at the time of gangliolysis. However, in 12 of the patients who had had earlier neurodestructive procedures, long-

lasting pain relief was achieved following gangliolysis. We were unable to identify pregangliolysis or postgangliolysis features of these patients which would enable us to predict in whom long-term success would be achieved and in whom there would be a relapse after gangliolysis.

Subsequent management of these seven patients involved a return to preoperative status in three, requiring acceptance of toxic side-effects or partial control, or both. Two of the patients in whom initially there was no benefit from Tegretol are adequately managed on reasonable doses of this drug following the gangliolysis. One patient finds the recurrent pain mild enough that he prefers not to take medication. In one other patient who had only minor pain symptoms, severe endogenous depression developed and his pain could not be adequately managed. In this series of 32, the condition was made no worse by the gangliolysis.

We were able to produce a sensory deficit in some portion of the painful region in all but one patient in whom, oddly enough, there was complete relief of first and second division tic douloureux by a lesion that was restricted to the third division. The lesion produced by gangliolysis extended to some degree into an adjacent division not involved by pain in 16 patients. However, the extended lesion involved only a portion of additional adjacent divisions, and was in no case detrimental to the patient's well-being. The sensory deficit was limited to pain and temperature perception in 22 of the 32 patients. In all but one of the remainder some degree of touch sensation was preserved.

Decrease in size and density of the sensory deficit occurred in most patients regardless of the long-term pain relief and some patients lost essentially all of their sensory deficit even though pain relief persisted.

In no case was a neurologic deficit produced outside the trigeminal nerve. Paresis of the ipsilateral muscles of mastication developed in nine patients but was symptomatic in just one patient with a earlier history of temporomandibular joint arthritis. No permanent impairment of jaw or masticatory function developed in any patient as a result of this procedure. When paresis of muscles of mastication was produced, it was invariably transient. Corneal anesthesia developed in four patients with return of sensation in two of these patients. In no patient did significant corneal pathology develop during the follow-up period.

In six of the 32 patients paresthesiae developed in the trigeminal distribution, but in no patient were they reported as being painful. Anesthesia dolorosa did not develop in any patient. There were no deaths, no infections and no other medical complications as a result of gangliolysis. One patient complained of transient tinnitus and ear fullness that was attributed to tensor veli palatini dysfunction. It was successfully treated with decongestant medications.

## Discussion

Of 32 patients in whom percutaneous radiofrequency trigeminal gangliolysis was done, there was initial relief of pain in all but one and in only 21 percent was there recurrence. There was no mortality, and no neurologic deficit outside of the trigeminal nerve. Preservation of some touch sensation was present in 30 of the 31 patients. Corneal anesthesia was present in four patients, two of whom regained their sensation, and in no patient did keratitis develop.

Our experience is similar to that reported in the larger series of gangliolyses by Sweet and Wepsic, Nugent and Berry, and Onofrio.<sup>16-18</sup> Sweet and Wepsic treated 214 patients with tic douloureux and in those with follow-up periods ranging from two and a half to six years there was a 22 percent relapse rate.<sup>16</sup> By repeating the procedure in the 33 patients who had relapses, up to six times, they were able to achieve an overall success rate of 97 percent.

Nugent and Berry treated 65 patients, with 1 to 41 months of follow-up. They had an 11 percent recurrence rate and in all but one of these patients successful management was achieved by repeating the procedure.<sup>17</sup>

Onofrio reported 135 patients with tic douloureux with a recurrence rate of 15 percent occurring two weeks to 14 months postoperatively.<sup>18</sup> In these 446 patients in whom radiofrequency gangliolysis was done, the success rate varies from 78 to 90 percent with follow-up ranging up to six years. By repeating the procedure the success rate is in the range of 90 to 95 percent. In the combined experience there was no mortality and in only one patient did transient neurologic deficit develop outside the trigeminal system. At least partial touch sensation was preserved in the analgesic zone in about 90 percent of the patients. Keratitis developed in 0.6 percent of the cases and anesthesia dolorosa in 1.3 percent of the cases.

These results can be contrasted with those obtained by using various surgical and neurolytic injections as reported in several large series. As shown in Table 1, percutaneous radiofrequency trigeminal gangliolysis offers a higher success rate and a lower complication rate than any other currently available procedure.

Trigeminal peripheral neurectomy is safe, having a low incidence of minor complications, but must be considered temporizing since there is essentially a 100 percent recurrence rate within one and a half years. Alcohol injections of the peripheral nerves fall into the same category. Alcohol injection of the ganglion can have long-term effectiveness, and the incidence of complications can be very small when meticulously carried out by experienced operators. However, injection of the ganglion carries a notoriously high incidence of severe complications and a very low success rate on repeat injections. It is very difficult to control the extent of the lesion produced, and this procedure seems to have no advantage when contrasted with percutaneous radiofrequency gangliolysis. Middle fossa trigeminal rhizotomy has been considered among the safest and the most definitive procedures and has a high chance of initial control of symptoms; yet it carries at least a 10 percent recurrence rate and about a 1 percent mortality. Total sensory deficit is common and is associated with a 50 percent rate of postoperative paresthesiae and a 5 percent rate of anesthesia dolorosa.<sup>13</sup> Keratitis is reported in at least 1 percent of the patients and facial nerve paralysis has been reported in 18 percent of the patients, although it is permanent in a smaller group.<sup>7</sup> All of the complications of intracranial surgical operation can follow this operation.

Jannetta has recently claimed that most cases of tic douloureux are due to compression of the trigeminal root by an aberrant blood vessel.<sup>22</sup> He advocates isolating the offending vessel from the nerve root by a small nylon sponge inserted via a posterior fossa craniectomy under general anesthesia. The long-term efficacy, morbidity and mortality of this procedure is not established; it does offer the promise of pain relief without any sensory loss.

It is obvious that none of the established surgical procedures can offer the combination of low morbidity and mortality with high success rate that can be achieved with percutaneous radiofrequency trigeminal gangliolysis. The advantages

of this procedure are: (1) high rate of therapeutic effectiveness, which can be made about 95 percent by repeating the procedure; (2) ability to preserve touch sensation in regions that are analgesic; (3) zero mortality; (4) virtually zero incidence of neurologic deficit outside the trigeminal system, and (5) low incidence of associated complications.

If we assume that in 70 percent of all patients with tic douloureux adequate control of pain can be achieved with Tegretol, and that of those in whom it is not controlled with Tegretol, 80 to 85 percent will have a good result with a single gangliolysis, 94 percent of such patients can be successfully treated by either drugs or a relatively inexpensive and safe operative procedure. Gangliolysis can be repeated if not initially successful and can approximate a 98 percent success rate in the treatment of what is surely one of the most painful afflictions of man. This success rate can be achieved with essentially no incidence of mortality and a very low incidence of morbidity and only partial sensory loss. For these reasons, we believe that percutaneous radiofrequency trigeminal gangliolysis has become the treatment of choice for tic douloureux not responsive to Tegretol or Dilantin.

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